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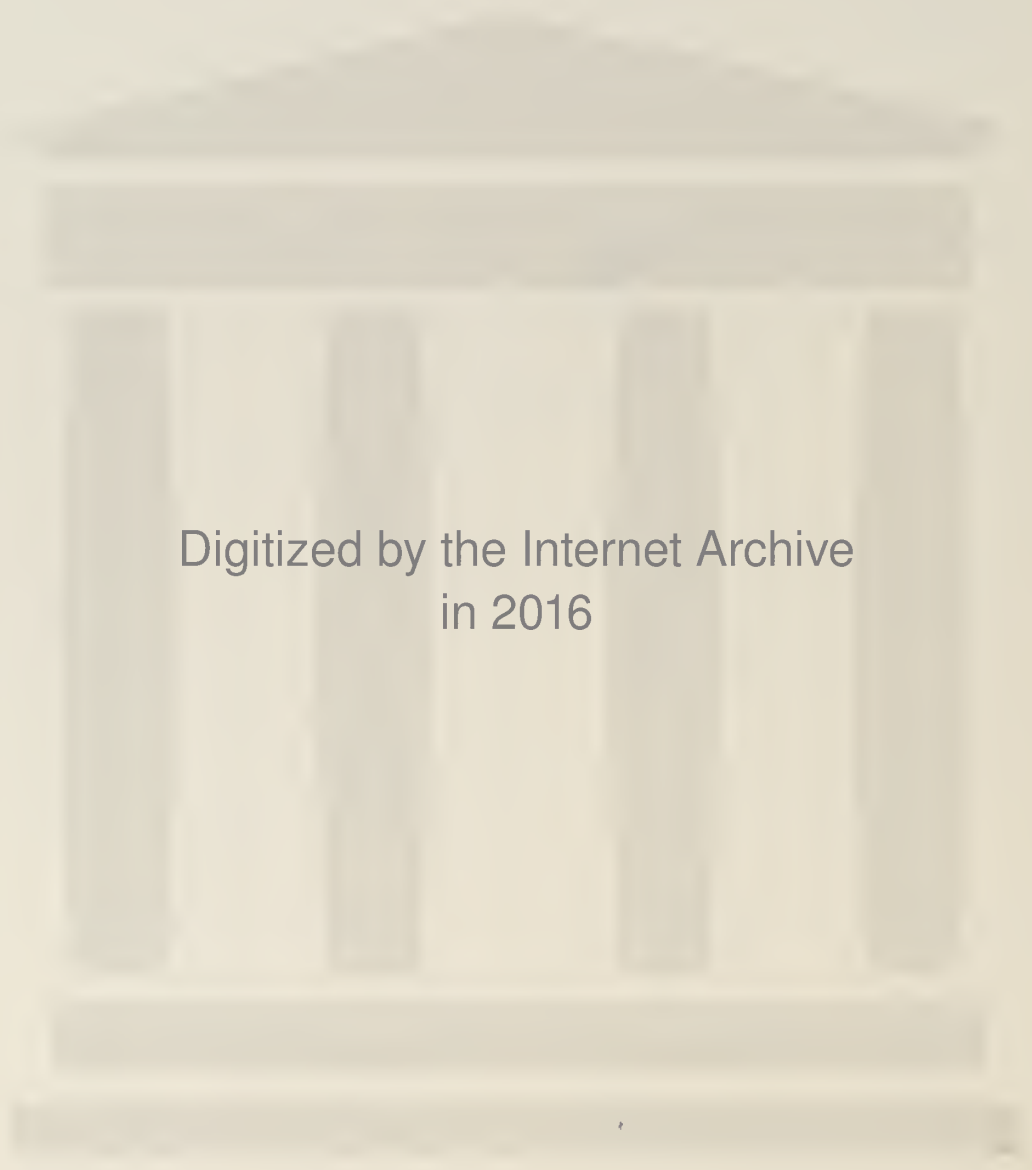
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POPULATIONS AND HOST PREFERENCES OF JUNE BEETLES
IN SOUTHERN WISCONSIN IN 1938By T. R. Chamberlin, C. L. Fluke, Lee Seaton, and J. A. Callenbach^{1/}

INTRODUCTION

The study of the flight and host preferences of June beetles of southern Wisconsin, which was initiated at the University of Wisconsin in 1935 and continued in 1936 and 1937, was also continued in 1938, a year of flight for the "A Brood," or major brood of beetles. The methods of investigation adopted were essentially the same as those of 1935, 1936, and 1937. These studies were reported in the Insect Pest Survey Bulletin, June 15, 1938 (supplement to No. 4, vol. 18). The purposes of this work are also discussed there.

The populations and host preferences of the various species of beetles were obtained by hand picking large numbers of beetles from the host plants on which they were feeding at night and determining the percentage of the total number of beetles of each species taken from each kind of plant. Some samples were taken from trees on which many beetles were concentrated by shaking branches over canvas, but such samples are not included in the data herein presented.

Many of the groves in which flight observations were made in 1938 were the same as those used in previous years; however, for various reasons, some of these had to be abandoned and others in the same neighborhood substituted. A few new localities were also selected. These groves were distributed over the southern part of the State between Racine on the east, Wyalusing on the west, Hancock on the north, and Lamont on the south (fig. 1). The plant complex differed in the various localities to a greater or less extent. In selecting these groves the same plan was followed as formerly, that is, to choose only such groves as contained the maximum number of the kinds of shrubs and trees that were general in the locality.

^{1/} Callenbach made the observations at Gays Mills, Boscobel, and Wyalusing; Chamberlin, Fluke, and Seaton the observations in all other localities. This project is part of the general program for investigation of June beetles and white grubs being conducted cooperatively by the Bureau of Entomology and Plant Quarantine, of the United States Department of Agriculture, and the Wisconsin Agricultural Experiment Station through its Department of Economic Entomology.

Usually collections were made by from 2 to 4 collectors between 7:30 and 11:30 p.m., although later in the season the flight might not begin until about 8:20 p.m. Sometimes, when small flights had occurred, the plants were well covered by the collectors before 11:30 p.m. A total of 71 collections were made from 25 groves between April 26 and July 29. Very few beetles were found late in June in other than the Gays Mills area and no collections were made after July 1, except at Gays Mills. The location of the groves and the number of collections made in each were as follows: Dane County--Dane, 5 collections; Waunakee, 1; Oregon, 1; Blue Mounds, 4; Columbia County--Lodi (Camp Perry), 3; Leeds, 4; Poynette, 2; Walworth County--Whitewater, 1; Racine County--Racine, 1; Kenosha County--Kenosha, 1; Fond du Lac County--Ripon, 1; Waushara County--Hancock, 1; Lafayette County--^{Lapont}~~Lapont~~, 6 in 2 groves; Iowa County--Linden, 3; Rock County--Edgerton, 4²; Grant County, Boscobel, 2 in 2 groves, Wyalusing, 1; Crawford County--Gays Mills, 16 in 1 grove and 14 in 5 other nearby groves. Figure 1 shows these localities.

The Gays Mills area which was studied most intensively differed from the other areas mainly in the absence of bur oak, the scarcity of Phyllophaga hirticula (Knoch) and predominance of P. rugosa (Melsh.). To include the collections from this area with those from other parts of the State would bias the averages on which the relative populations of the various species throughout the southern part of the State are based. For this reason, the collections from the Gays Mills area are, for the most part, considered separately from the others.

Number of Beetles and Species Collected

A total of 24,219 beetles, belonging to 18 determined and 1 undetermined species, were taken. Although this number exceeds slightly the total collected in the previous 3 years, the beetles did not seem so numerous as in 1935 (the previous flight of "A Brood"), except in Lafayette and Iowa Counties, where Phyllophaga hirticula Knoch was very abundant. Of the 24,219 beetles, 9,759, or 40.29 percent, were P. rugosa (Melsh.); 6,702, or 27.67 percent were P. hirticula; 4,845, or 20.00 percent, were P. fusca (Froel.); and 738, or 3.05 percent, were P. prunina (Lec.). Collectively, these 4 species comprised 91.02 percent of the beetles collected. The first 3 of these species were most abundant, in the same order, in 1935 but in that year P. tristis (F.), rather than P. prunina was fourth. Of species having a 3-year life-cycle, the same 3 species have been most abundant each year since 1935, inclusive, except in 1936, when P. hirticula was rare. In 1936 P. tristis, which has a 2-year cycle, was extremely abundant and greatly exceeded all other species in numbers. Because of this high population in 1936, a heavy flight of this species would have been expected in 1938, but field diggings had shown that P. tristis had laid very few eggs in the extremely dry soils of that year and very few grubs of that brood were found in the years following. Table 1 shows the numbers of beetles of each species taken and the percentage of the total comprised by each.

^{2/} In this case the grove was a short distance northwest of Edgerton in Dane County.

Beetles Collected in Other Than the Gays Mills Area

Outside the Gays Mills area, between April 27 and June 30, 16,468 beetles were taken in 41 collections from 16 groves. The predominant species were P. hirticula, P. rugosa, and P. fusca. These furnished 40.13, 24.16, and 20.77 percent, respectively, of the total beetles, collectively 85.06 percent. P. hirticula was very abundant in Lafayette and Iowa Counties, where it represented about 90 percent of all beetles taken in each collection. Not a single specimen of P. rugosa was taken at Lamont, the collection area for Lafayette County, and only 3 at Linden, the collection area for Iowa County. P. fusca was rather generally distributed. P. prunina was collected almost entirely from sandy areas near Lodi, Poynette, and Boscobel. The number of all beetles taken and the proportion of the total represented by each are shown in the "totals" line of table 2. The lower of the 2 percentages in each space is the one that applies in this case.

Beetles Collected in the Gays Mills Area

In the Gays Mills area 30 collections were made between April 26 and July 29. These included 16 collections from the regular grove in and adjoining the sample pasture in which grub populations and species have been studied for several years past and 14 from 5 groves within a mile of the sample pasture which, for the most part, consisted of shrubs in or adjoining apple or cherry orchards. The grove adjoining the sample pasture included about 10 cherry trees in an adjacent commercial planting.

Table 1.--Relative abundance of various species of beetles collected in 1938

Species	Beetles	
	Number	Percentage of total
<u>P. rugosa</u> (Melsh.)-----	9,759	40.29
<u>P. hirticula</u> (Knoch)-----	6,702	27.67
<u>P. fusca</u> (Froel.)-----	4,845	20.00
<u>P. prunina</u> (Lec.)-----	738	3.05
<u>P. implicita</u> (Horn)-----	597	2.47
<u>P. tristis</u> (F.)-----	502	2.07
<u>P. balia</u> (Say)-----	269	1.11
<u>P. drakei</u> (Kby.)-----	246	1.02
<u>P. ilicis</u> (Knoch)-----	211	.87
<u>P. futilis</u> (Lec.)-----	135	.55
<u>P. nitida</u> (Lec.)-----	117	.48
<u>P. crenulata</u> (Froel.)-----	39	.16
<u>P. marginalis</u> (Lec.)-----	18	.07
<u>P. anxia</u> (Lec.)-----	18	.07
<u>P. spreta</u> (Horn)-----	10	.04
<u>P. inversa</u> (Horn)-----	7	.03
<u>P. villifrons</u> (Lec.)-----	2	.01
<u>P. forsteri</u> (Burm.)-----	3	.01
<u>P. sp.</u> -----	3	.01
Total-----	24,221	99.98

A total of 7,751 beetles were taken. Of these P. rugosa comprised 74.58 percent, P. fusca 18.38 percent, P. balia 2.59 percent, and P. ilicis 2.44 percent. Together these species supplied 97.99 percent of the total. The number of beetles of each species taken and the proportion of the total each species represents are shown in the "total" line at the bottom of table 3. It may be noted that P. hirticula was scarce in this area, as was P. rugosa in Lafayette and Iowa Counties.

Host Preferences of the Beetles outside the Gays Mills Area

Table 2 gives a complete list of the kinds of host plants from which collections were made in the southern part of the State, excluding the Gays Mills area, and the numbers of beetles of each species taken from each kind of plant. These tables are identical in form with those which appeared previously in Supplement to Number 4, Volume 18, of the Insect Pest Survey Bulletin. There are 3 entries in each space consisting of 2 percentages and a number. The percentage at the top represents the proportion of the species of beetles appearing at the top of the column, which were taken from the host plant at the left, and the lower percentage represents the proportion of the total beetles collected from the host mentioned at the left, representing the species at the top of the column. The middle number in each group of figures represents the number of beetles of the species mentioned at the head of the column, collected from the host plant mentioned at the left. Thus 3,520 P. hirticula were taken from hazel. These represented 53.27 percent of the total beetles of this species and 76.71 percent of the total beetles of all species taken from hazel.

P. hirticula was taken from 27 kinds of plants. Hazel, bur oak, hickory, and aspen supplied 53.27, 21.87, 4.96, and 4.71 percent of the total number of beetles and together 84.81 percent of the total for this species.

P. rugosa was collected from 31 kinds of plants. Aspen, red oak (group), hazel, hickory, willow, dogwood, and bur oak supplied 17.22, 16.97, 11.44, 10.26, 8.04, and 7.89 percent of the total number of beetles, respectively, and together 80.03 percent of the total for this species. It is apparent that P. rugosa is more diversified in its feeding habits than is P. hirticula.

P. fusca was taken from 26 kinds of plants. Dogwood, red oak (group), bur oak, aspen, and hazel supplied 35.15, 19.47, 10.12, 8.57, and 8.07 percent of the total, respectively, and together 81.38 percent of the total for this species.

P. prunina was taken from 13 kinds of plants. Of these oaks of the red oak group and hazel supplied 81.03 and 10.84 percent, respectively. Preferred hosts of the other species of beetles may be found in table 2.

Host Preferences of the Beetles in the Gays Mills Area

Host preferences of the various species of beetles in the Gays Mills area are shown in table 3, which is identical in form with table 2. The most abundant species, P. rugosa, was found on 29 kinds of plants, cultivated

Table 2.--Beetles Collected in Southern Wisconsin Outside of Gays Mills Area, 1938

Hosts	<i>P.hirticollis</i>	<i>P.rugosa</i>	<i>P.fusca</i>	<i>P.annua</i>	<i>P.implicita</i>	<i>P.tristis</i>	<i>P.draxii</i>	<i>P.fusilis</i>	<i>P.nitida</i>	<i>P.bulbi</i>	<i>P.crenulata</i>	<i>P.liciae</i>	<i>P.marginalis</i>	<i>P.eximia</i>	<i>P.villifrons</i>	<i>P.laevius</i>	<i>P.spp.</i>	Total
	53.27% 3520	11.44% 455	8.07% 276	10.84% 80		.44% 2	33.83% 82	38.33% 51	13.12% 28	7.17% 13	34.55% 12	13.33% 2		100% 1			27.87% 4589	
Basel	76.71% 263	9.92% 675	6.01% 666	1.74% 598		.04% 7	1.77% 159	1.11% 81	1.46% 27	.26% 4	.61% 1	.26% 1	.04% 3	.02% 1			99.99% 15,108	
Red Oak	10.95% 21.87%	27.14% 1.85%	20.78% 10.12%	24.05% 1.14%	.28% 1.16%	6.33% 57.93%	1.26% 2.07%	3	2.88% 1.50%	1.12% 2.88%	1.03% 14.71%	.16% 2.56%	1.03% 18.18%	20% 20%	3 4	3 3	9.97% 10.46%	
Burr Oak	59.71% 59.71%	12.97% 12.97%	14.30% 14.30%	.04% .04%	.04% .04%	11.78% 11.78%	.21% .21%	.08% .08%	.12% .12%	.44% .44%	.04% .04%	.16% .16%	.12% .12%				99.98% 9.97%	
Dog Wood	37 37	320 320	1202 1202	2 2	3 3	46 46	9 9	20 20	2 2					9.09% 9.09%	1 1		9.99% 9.99%	
	4.71% 311	17.22% 685	8.57% 293		34.12% 203	.20% 1	2.07% 5	2.26% 3					9.09% 2		9.09% 2	1 1	9.13% 1504	
Aspen	20.68% 4.96%	46.55% 11.21%	19.48% 4.05%		13.50% .50%	.07% .32%	.33% .32%	.20% .75%			7.35% 5		33.33% 1	9.09% 1			100.01% 5.76%	
Hickory	34.60% 10	47.05% 408	16.77% 53	.14% 1	.32% 3	.44% 2	2.07% 5	.75% 1	.53% 1						54.55% 6		100% 5.10%	
Willow	1.19% 2.00%	48.57% 4.95%	6.31% 5.73%	.12% 1.75%	42.14% 32	.24% 15	.60% 2.20%	.12% .75%		.96% 1	7.35% 5	5.13% 2					100% 3.60%	
White Oak	22.26% .53%	32.88% 2.95%	33.05% 2.46%	2.19% 1.63%	5.40% .20%	2.53% .44%	.17% .75%	.17% .17%	.84% .34%	.34% .34%							100% 1.54%	
Buttermt	13.83% 1.17%	47.04% 2.35%	33.20% .53%	4.74% .34%	.40% .44%	.40% .40%	.40% .40%			1.47% 1							100.01% 1.54%	
Wild Plum	37.18% 2.04%	46.12% .85%	8.74% .23%	.97% .16%	.97% .44%	.97% .83%	5.34% 5.26%	3.89% 3.89%	.42% .42%					100% 1			100.01% 1.18%	
Rose	69.59% 2.22%	17.52% .55%	4.12% .12%	.52% .12%	1.03% 1.03%	1.03% 1.03%	3.61% 1.50%	2.06% 1.50%			2.55% 1				.52% 1		100% 1.07%	
Crataegus	83.52% 1.20%	12.50% .80%	2.27% 1.11%	.95% .95%	.16% .16%		1.14% 8.27%	1.14% 2.88%			.58% 9.09%						100.01% 1.05%	
Raspberry	45.66% 15	18.50% 32	21.97% 79	4.05% 7	1.85% 1		6.35% 38	1.73% 3		1.47% 1		1.16% 2					100.01% 473	
Poplar (except Aspen)	53.75% .53%	30% .58%			13.75% .23%		1.2% .23%			1.2% .23%							100% .40%	
Walnut	53.03% .15%	34.85% 14	12.12% 13	.14% 1	1.51% 9		6.77% 9	1.92% 2	1.47% 1				18.18% 2				100% 37%	
Elm	16.32% .24%	22.99% .25%	21.71% .47%	1.64% .50%	14.75% .50%		3.28% .50%	1.64% .50%					3.28% .50%				99.99% .26%	
Wild Cherry	37.21% 16	23.22% 10	32.56% 14	6.98% 3													100% 43	
Red Clover	.02% 1	.33% 13	.03% 1	.95% 7													100% 19	
Box Elder	4.54% .02%	59.09% .48%	4.54% .48%	31.82% .12%													99.99% 20	
Timothy	.08% 5	.03% 1	.06% 2	1.36% 10	.20% 1												100% 12%	
Alder	26.31% .02%	5.26% .25%	10.53% 1	52.63% .50%		5.26% 1					5.13% 2		13.33% 2				99.99% .09%	
Sunflower	6.67% 1	66.67% 10									13.33% 2		13.33% 2				100% 15	
Basswood	.03% 1	.03% 1	.03% 1					7.52% 10									.07% 12	
Gooseberry	.09% 6	.05% 2	3.33% 1					83.33% 10									99.99% .05%	
	66.67% .14%	22.22% 9						11.11% 1									100% .09%	
Nettle-like Plant	100% 9																100% 9	
Blackberry	.02% 1	.03% 1	.03% 1			.20% 1		2.26% 3	.96% 1								.05% 8	
Prickly Ash	12.50% 1	12.50% 1	12.50% 1		12.50% 1			37.50% 5	12.50% 1								100% .03%	
Cultivated Cherry								100% 5									100% 5	
Service Berry	.02% 1	.05% 2	.03% 1														100% .02%	
Grass	25% 1	50% 2	25% 1														100% .02%	
Lead Plant				100% 4													100% 4	
Maple	.05% 2									2.94% 2							.02% 4	
Ironwood	.02% 1	.05% 2								50% 1							.02% 3	
Vetch-like Legume	25% 1	75% 3															100% .02%	
Chinese Elm	.02% 1					.20% 1		100% 2									100% .01%	
Grape	50% 1					50% 1				1.47% 1	2.55% 1						100% .01%	
Woodbine								.75% 1		50% 1	50% 1						100% .01%	
Sweet Clover	.03% 1							100% 1									100% .01%	
Alsike Clover	100% 1							.75% 1									100% .01%	
Hollyhock								100% 1									100% 1	
Garden Plant Undetermined	.03% 1							.75% 1									.01% 1	
Morning Glory	100% 1							100% 1									100% .01%	
Golden Rod	.02% 1																100% .01%	
Pyrus	100% 6608																100% 16468	
Totals	100.05% 40.13%	100.01% 24.16%	100.02% 3420	100.02% 738	99.98% 598	100% 492	100.01% 242	99.99% 133	99.98% 104	100% 68	99.99% 39	100.01% 22	99.99% 15	100% 11	100% 1	100% 1	100.00% 16468	

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Table 3.--Beetles Collected in Gaye Mills Area, 1938.

Beetle	<i>P. rugosa</i>	<i>P. fusca</i>	<i>P. balia</i>	<i>P. pilicla</i>	<i>P. hirticollis</i>	<i>P. nitida</i>	<i>P. tristis</i>	<i>P. sprucei</i>	<i>P. anxia</i>	<i>P. inversa</i>	<i>P. drakei</i>	<i>P. marginalis</i>	<i>P. forsteri</i>	<i>P. implita</i>	<i>P. villosa</i>	<i>P. spp.</i>	Totals
Butternut	21.9%	25.3%	15.4%	24.3%	32.9%	7.6%	10.0%	10.0%	14.2%	66.6%			33.3%		100.0%		22.5%
	126	361	31	46	31	1	1	1	1	4			1		1		178
Cherry (Cultivated)	72.6%	20.6%	1.7%	2.6%	1.7%		.06%	.06%	.06%	.2%							100.0%
	22,504	17,174	4,988	2,654	1,064		30,000	20,000									20,374
	1304	292	10	5	1		3	2									1519
Hickory	82.5%	16.0%	.6%	.3%	.06%			.1%	.12%								99.9%
	12,324	14,884	35,824	11,644	22,344		20,000		14,284	33,334	50,000		33,334				13,514
	712	212	72	22	21		2		1	2	2		1				1047
Hazel	68.0%	20.2%	6.8%	2.1%	2.0%		.1%		.1%	.1%							100.0%
	14,504	3,194	13,454	33,134	27,864		38,464	20,000		42,864	25,000		33,334			50,000	13,244
	843	54	27	63	26		5	2		3	1		1				1026
Basel	82.1%	5.2%	2.6%	6.1%	2.5%		.4%	.1%		.2%		.1%	.1%				99.9%
	5,624	1,474	3,174	3,174	83,084			10,000	14,284								4,614
	325	21	6	6	3		1	1									357
Basewood	91.0%	5.8%		1.6%						.2%							100.0%
	484	19,304	6,974	6,884	15,384			40,000		.2%							4,554
	48	275	14	13	2			4									356
Wild Plum	13.4%	77.2%	3.9%	3.6%				1.1%									99.9%
	4,094	2,994	4,484	2,654	7,454						25,000	33,334	33,334				3,874
	234	42	9	5	7						1	1	1				300
White Oak	78.0%	14.0%	3.0%	1.6%	2.3%						.3%	.3%	.3%				99.9%
	4,604	14,004	6,474	4,234	2,134		7,694										3,774
	266	2	13	8	1		1										292
Ironwood	91.1%	.6%	4.4%	2.7%	.6%		.3%										99.9%
	3,624	1,824	1,004	1,064	1,064												3,074
	209	25	2	4	1												238
Aspen	87.8%	10.2%	.8%		.4%												100.0%
	3,114	.214	.504	2,124	1,064								33,334	50,000			2,464
	180	3	1	4	1							1	1				191
Wln	94.2%	1.5%	.5%	2.0%	.5%							.5%	.5%				99.9%
	2,904	.074	1,004	2,124													2,304
	171	2		4													178
Crataegus (1)	96.0%	.5%	1.1%	2.2%													100.0%
	1,124	3,094	7,464	1,064	1,064		20,000	10,000								50,000	1,654
	69	44	15	2	2		2	1								1	131
Red Oak	49.6%	33.5%	11.4%	1.5%	1.6%		7.6%	1.5%		.7%						.7%	100.0%
	1,184	5,124	1,934	1,594	1,064		1	10,000	1	14,284							1,134
	8	73	4	3	1		1		1	1							92
Dogwood	8.7%	72.3%	4.3%	3.2%	1.0%		1.0%	1.0%	1.0%								100.0%
	.5%	.424		1.5%	2.1%												.5%
	34		3	2													46
Pigment Hickory	75.5%	13.1%		6.6%	4.4%												100.0%
	.054	2,394															.484
	3	34															37
Ash	8.1%	91.8%															100.0%
	.574																.434
	33																33
Apple (Cultivated)	100.0%																100.0%
	.404																.304
	23																23
Mint	100.0%																100.0%
	.3%	.074															.274
	20																23
Boxelder	99.2%	4.7%															100.0%
	.164																.1%
	9																12
Poplar (Except Aspen)	75.0%		25.0%														100.0%
	.034	.704															.154
	2	10															12
Crataegus (2)	16.6%	83.3%															100.0%
	.194	.074															.154
	11																12
Gooseberry	91.6%	8.3%															100.0%
	.034	.144															.054
	2																4
Blackberry	50.0%	50.0%															100.0%
	.074																.054
	4																4
Feed	100.0%																100.0%
	.024																.034
	1																2
Grass	50.0%		50.0%														100.0%
	.144																.034
	2																2
Pyrus	100.0%																100.0%
	.024	.504															.034
	1	1															2
Sunsc	50.0%	50.0%															100.0%
	.024																.014
	1																1
Wild Cherry	100.0%																100.0%
																	.014
																	1
Maple																	100.0%
	.024																.014
	1																1
Wallah	100.0%																100.0%
	.024																.014
	1																1
Strawberry	100.0%																100.0%
	.024																.014
	1																1
Rose	100.0%																100.0%
	.074																.014
	1																1
Elderberry	100.0%																100.0%
	.074																.014
	1																1
Poison Ivy	100.0%																100.0%
	180,024	99,994	100,024	100,024	99,994	99,994	100,004	100,004	99,984	100,004	100,004	99,994	99,994	100,004	100,004	100,004	99,994
	5781	1425	201	189	13	10	10	10	7	6	4	3	2	1	2	2	100,014
Totals	74.5%	18.3%	2.5%	2.4%	1.2%	.17%	.13%	.13%	.07%	.08%	.06%	.04%	.04%	.03%	.01%	.03%	100.0%

cherry, butternut, hazel, hickory, basswood, and ironwood supplying 22.56, 21.95, 14.58, 12.32, 5.62, and 4.60 percent of the total, respectively, and collectively 81.63 percent of the total for this species.

P. fusca was collected from 22 kinds of host plants. Butternut, wild plum, cultivated cherry, hickory, ironwood, and dogwood supplied 25.33, 19.30, 17.75, 14.88, 14.00, and 5.12 percent of the total, respectively, and together 96.38 percent of the total for this species.

P. balia was found on 13 kinds of host plants. Hickory, butternut, hazel, red oak (group), wild plum, and ironwood supplied 35.82, 15.42, 13.43, 7.46, 6.97, and 6.47 percent of the total, respectively, and together these 6 hosts supplied 85.57 percent of the total for this species.

P. ilicis was collected from 16 kinds of plants. Hazel, butternut, hickory, wild plum, and ironwood supplied 33.33, 24.34, 11.64, 6.88, and 4.23 percent of the total, respectively, and together 80.42 percent of the total for this species. The various hosts of the less abundant species are given in table 3.

Flight Habits of the Beetles

In general, observations on the flight habits of June beetles in 1938 were in agreement with those made in previous years. P. fusca and P. tristis emerged earlier in the season and at lower temperatures than did the others, but P. tristis was rare and no close check could be kept on the conditions that governed its emergence. In the case of P. fusca, however, comparisons were made of its seasonal and temperature reactions with several other common species. P. tristis is not considered in the following discussion, but its relative population is indicated on some of the charts.

P. fusca, in addition to issuing earliest in the season, was most numerous for some weeks after its initial emergence, whether temperatures were low or high. At Dane on the night of April 27, when the air temperature was 71° F. and the soil temperature just below the surface 67°, the beetles caught were almost exclusively P. fusca and the flight was of fair size. Essentially the same conditions prevailed on May 2, but P. rugosa and P. balia were then appearing.

Later in the season the effect of temperature on the emergence of different species was more clearly shown. In some areas, by May 2, species other than P. fusca predominated when the temperatures were high enough, but when temperatures were below approximately 55° F. the proportion of P. fusca beetles increased. At Dane on May 23, when the air temperature was 51° and the soil temperature 59° the beetles were mostly P. fusca; at Leeds on May 13, when the air temperature was 48°, the beetles were exclusively P. fusca; but at Dane on June 2, with the air temperature at 64°, both P. rugosa and P. hirticula were about five times as numerous as P. fusca; and at Leeds on June 13, with the air temperature at 62°, P. rugosa again was about five times as numerous as P. fusca.

P. fusca does not persist in the fields in any numbers as late in the season as some of the other species, especially P. rugosa, and some of the decline in the proportion of the total comprised by this species late in the season was caused by the slow decrease in numbers in the field. That the temperature, however, is of importance in determining the extent to which this species emerges is shown in figures 2, 3, and 4, in which the percentage of the total beetles represented by each species is shown for different localities and on various dates, together with the air temperatures prevailing at the beginning of the flight. To avoid error in interpreting these charts one should bear in mind that no indication is given on them of the actual numbers of beetles taken, and that P. fusca predominated earlier in the season and P. rugosa and P. hirticula later.

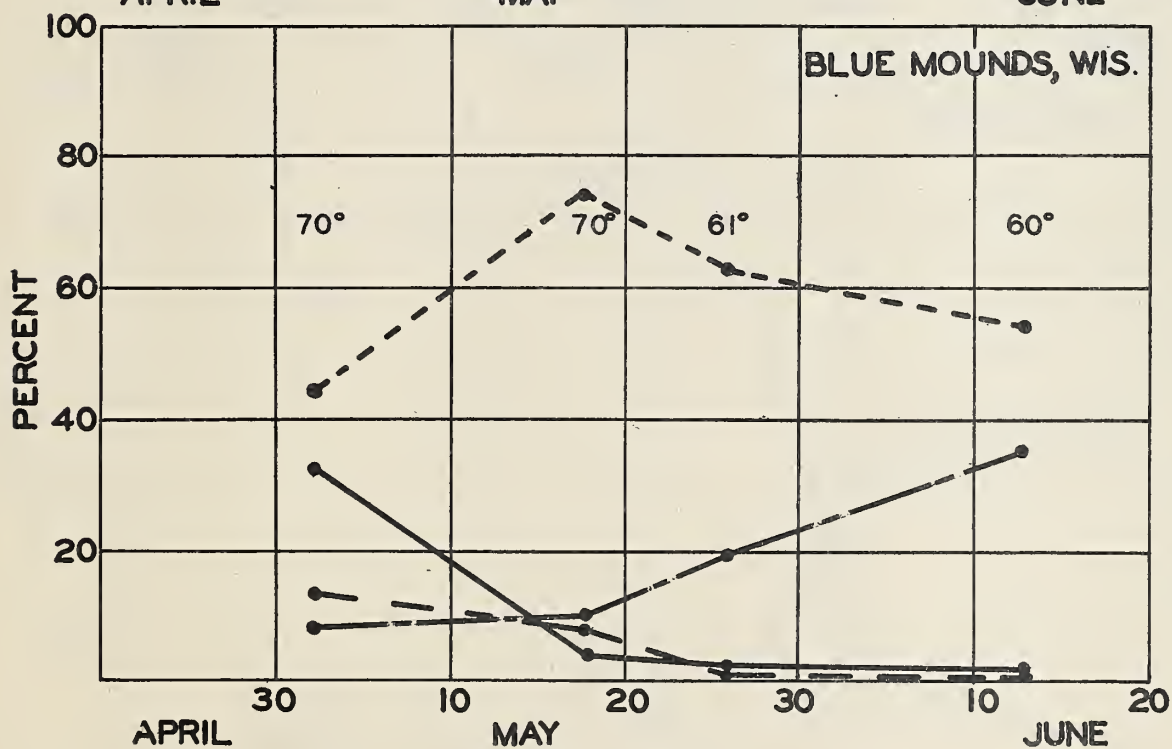
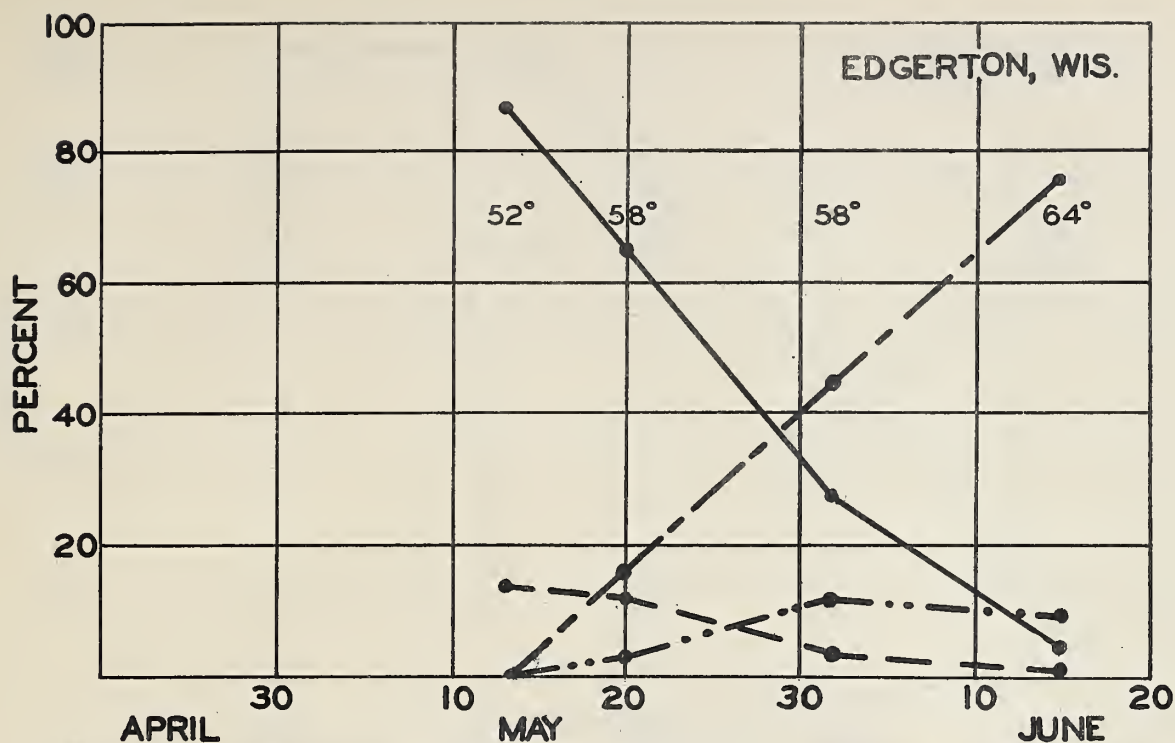
The chart for the Gays Mills grove (fig. 4) shows best the direct effect of temperature on emergence. Both P. fusca and P. rugosa are common in this area. It may be noted from this chart that on April 26, with an air temperature of 73°F., over 90 percent of the beetles were P. fusca. This was probably because none of the other species had begun to emerge by that date. By May 2, when the temperature was still high and P. rugosa had begun to emerge, most of the beetles were P. rugosa; however, on May 10, when the temperature was 54°, about 60 percent of the beetles were P. fusca and by May 12, when the temperature was 54°, this species had increased to almost 90 percent. When the temperature rose to 61° on May 16, the positions of the two species became again reversed, after which temperatures remained high and P. fusca beetles were always in the minority. This chart also shows that P. ilicis emerges late in the season and does not become abundant until considerably after its initial emergence.

Figure 2 shows the temperature and seasonal relationships at the Dane grove, where P. fusca, P. rugosa, and P. hirticula are common. Early in the season, although temperatures were high, P. fusca predominated, and the low temperature of May 23 increased its proportions. After this date, temperatures remained high and this species remained in the minority. It may be noticed that the curve for P. rugosa and P. hirticula in this area are almost identical.

Figure 2 represents similar data from the Leeds grove. In this area P. fusca and P. rugosa predominate. The first three collections were made when temperatures were 56° F., or lower. In all three collections, P. fusca beetles were most abundant and in the first two no other species was taken. On June 13, with a temperature of 62°, P. rugosa predominated.

At Edgerton P. fusca and P. rugosa also predominated. P. hirticula was abundant there in 1935, the year of the previous "A Brood" flight, but scarce in 1938. Figure 3 shows that, of the four predominant species, P. fusca was the most abundant on May 13, when the temperature was 54° F. and on May 20, when the temperature was 58°, but had declined by June 2, when the temperature was also 58°. Apparently 58° is high enough to produce a slow emergence of P. rugosa when the season is sufficiently advanced.

Blue Mounds is near the north edge of the area in which P. hirticula is much more abundant than any other species. P. hirticula was predominant at Blue Mounds, but P. rugosa and P. fusca are also fairly abundant. Figure 3 shows P. hirticula to be most numerous in all the collections made in that area. P. fusca was more common than P. rugosa in the first collection, but diminished in numbers afterward as P. rugosa increased.



P. FUSCA —————
 P. RUGOSA - - - - -
 P. HIRTICULA - - - - -
 P. TRISTIS — — — — —
 P. IMPLICITA -

Figure 2.--Proportional populations of various species of Phyllophaga on different dates at different temperatures, 1938.

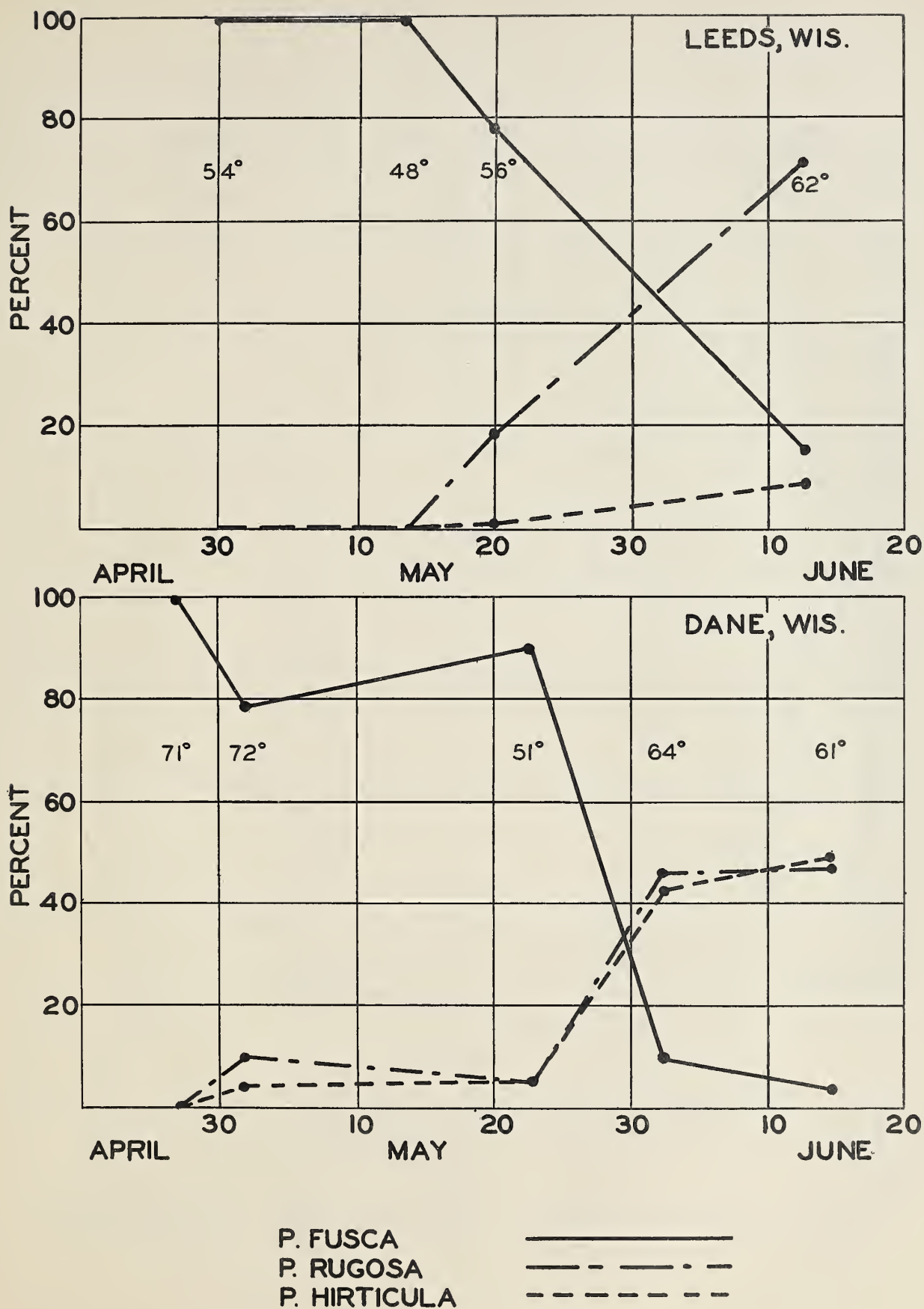


Figure 3.--Proportional populations of various species of *Phyllophaga* on different dates and at different temperatures, 1938.

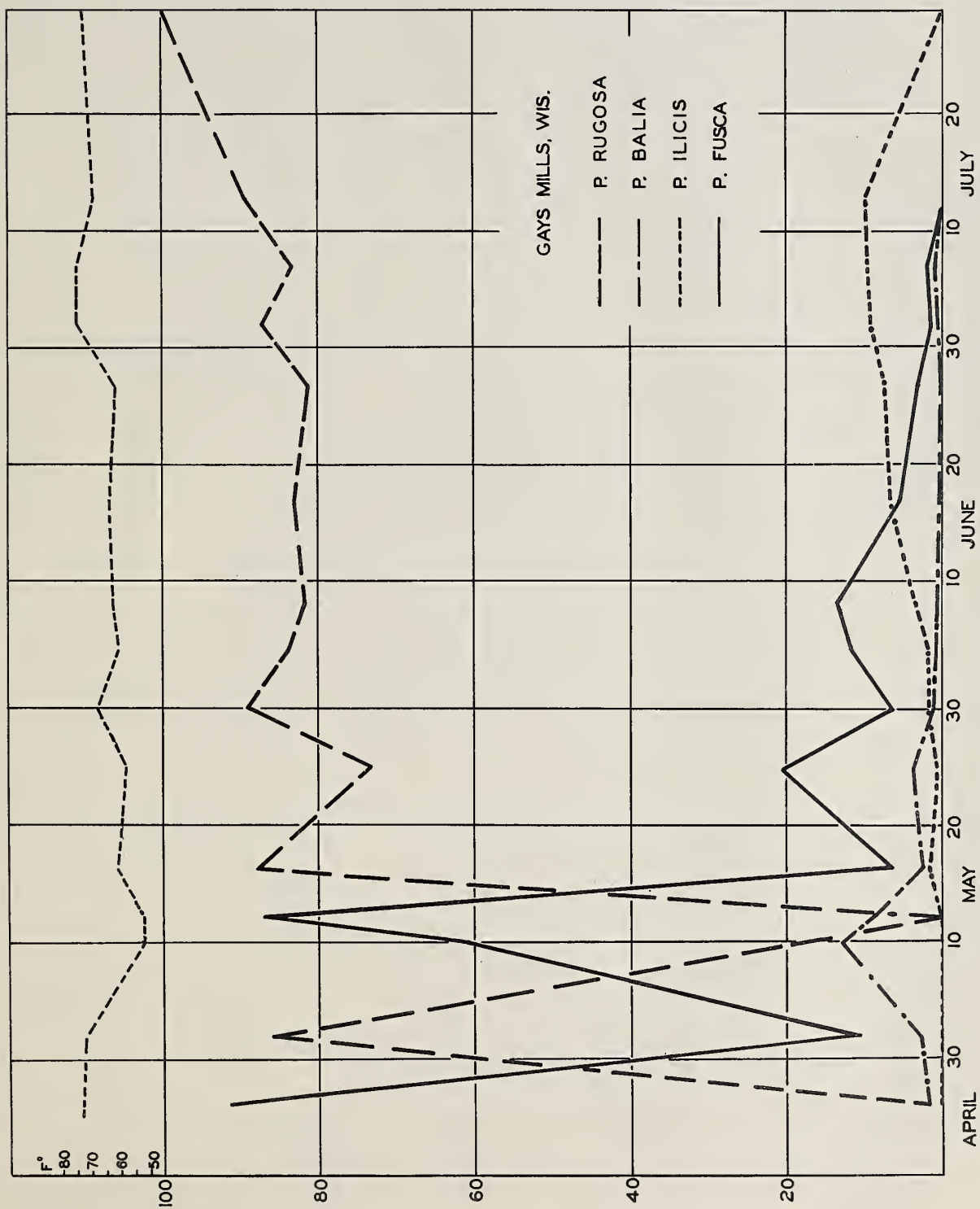


Figure 4.--Proportional populations of various species of *Phyllophaga* on different dates and at different temperatures, 1938.

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